Biological and Habitat Data for Fish Collected During Stream Surveys in the Deh Cho Region, Northwest Territories, 2006

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2007

Canadian Data Report of Fisheries and Aquatic Sciences 1190

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Cat. No. Fs 97-13/1190E ISSN 0706-6465

Correct citation for this publication:

Mochnacz, N. J and J. D. Reist. 2007. Biological and habitat data for fish collected during stream surveys in the Deh Cho Region, Northwest Territories, 2006. Can. Data Rep. Fish. Aquat. Sci. 1190: vii + 21 p.

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ABSTRACT

Mochnacz, N. J and J. D. Reist. 2007. Biological and habitat data for fish collected during stream surveys in the Deh Cho Region, Northwest Territories, 2006. Can. Data Rep. Fish. Aquat. Sci. 1190: vii + 21 p.

Stream surveys were conducted in selected reaches of three streams in the Deh Cho Region during July, 2006. Streams were electrofished and habitat availability and use were recorded. A total of 223 fish representing eight different species were captured. Slimy sculpin was the most abundant species in this area representing 70.4 % of the total catch followed by lake chub (16.6 %), Arctic grayling (6.3 %), burbot (2.2 %), white sucker (2.2 %), and northern pike (1.3 %). Emerald shiner and round whitefish accounted for only 0.8 % of the catch. Lake chub were found in all of the streams surveyed. Mean depths ranged from 7.8 cm to 46.3 cm, mean velocities ranged from 0.19 $m \cdot s^{-1}$ to 0.73 $m \cdot s^{-1}$, cobble and pebble was the most common substrate found, and cobble and boulder was the predominant cover observed. Mean temperatures were 13.3 °C for Smith Creek and 16.5 °C for White Sand Creek.

Key Words: Northwest Territories; stream surveys; Arctic; Mackenzie Gas Pipeline; fish habitat; Arctic grayling; Deh Cho; Hodgson Creek; White Sand Creek; Smith Creek.

RÉSUMÉ

Mochnacz, N. J et J. D. Reist. 2007. Données sur la biologie et l'habitat des poissons pris lors du recensement des cours d'eau dans la région de Deh Cho, Territoires du Nord-Ouest, 2006. *Can. Data Rep. Fish. Aquat. Sci*. 1190: vii + 21p.

Le recensement des cours d'eau a été réalisé dans des passages sélectionnés de 15 cours d'eau dans la région de Deh Cho en juillet 2006. On s'est livré à la pêche électrique dans les cours d'eau et la disponibilité et l'utilisation de l'habitat ont été enregistrées. Un total de 223 poissons représentant huit espèces différentes ont été capturés. Le chabot visqueux était l'espèce la plus abondante dans la région, représentant 70,4 % de la prise totale, suivi par le méné de lac (16,6 %), l'ombre de l'Arctique (6,3 %), la lotte (2,2 %), le meunier noir (2,2 %), et le grand brochet (1,3 %). Le méné émeraude et le ménomini rond représentaient seulement 0,8 % de la prise. Le méné de lac se trouvait dans tous les cours d'eau recensés. Les profondeurs moyennes se trouvaient entre 7,8 cm et 46,3 cm, les vitesses moyennes se trouvaient entre 0,19 $m \cdot s^{-1}$ et 0,73 $m \cdot s^{-1}$, le substrat le plus courant était formé de galets et de cailloux, et la couverture prédominante observée était formée de galets et de rochers. Les températures moyennes étaient 13,3 °C pour le ruisseau Smith et 16,5 °C pour le ruisseau White Sand.

Mots-clés : Territoires du Nord-Ouest; recensement des cours d'eau; Arctique; gazoduc du Mackenzie; habitat du poisson; ombre de l'Arctique; Deh Cho; ruisseau Hodgson; ruisseau White Sand; ruisseau Smith.

INTRODUCTION

The Mackenzie River originates in northeastern British Columbia and flows north approximately 4,000 km to the Beaufort Sea. The Mackenzie Delta is a combination of channels, lakes (~ 24,000), and delta plains, encompassing an area of approximately 13,000 km^2 (Mackenzie River Basin Board 2003). The higher elevation areas (i.e., delta plains) are within the river's floodplain but are capable of supporting flood tolerant plant species such as mature spruce forests (Hirst et al. 1987). Freshwater and anadromous fish use the Mackenzie River and associated tributaries at different times of the year (Dryden et al. 1973). The main stem of the river is used by fish for short- and long-range migrations, feeding, and as winter habitat. Some fish species spend much of the year in the Mackenzie River; however, most species, especially anadromous ones, use the river as a migration corridor to spawning and feeding areas. Tributaries of the river are used by fish for spawning in the spring or fall and occasionally during the winter (Hatfield et al. 1972; Dryden et al. 1973).

The proposed Mackenzie Gas Pipeline (MGP) will intersect 495 watercourses along the Mackenzie River Valley from Inuvik, NT to northwestern Alberta (Imperial Oil Resources Ventures Limited 2004). These watercourses range from intermittent swales, which provide seasonal fish habitat, to much larger tributaries such as Great Bear River, which provide year-round fish habitat. In anticipation of increased activities related to pipeline construction and operation, studies were initiated in 2004 by Fisheries and Oceans Canada (DFO) to fill data gaps and update existing baseline data on fisheries resources along the Mackenzie River Valley. Although fish species found within the entire valley could be affected by environmental disturbance, this research focused primarily on the east side of the Mackenzie River. Research was conducted on fisheries resources along the Mackenzie Valley in the late 1970's (e.g., Hatfield et al. 1972; Dryden et al. 1973) and during the 1980's as part of the Northern Oil and Gas Action Program (e.g., Chang-Kue and Jessop 1991). However, filling data gaps and collecting up-to-date baseline information is important to establish pre-development reference conditions. Such information can be used for post-development monitoring to detect changes in the future.

The Mackenzie River supports 34 known species of freshwater and/or anadromous fish. These fish communities exhibit primarily riverine life histories, and are part of a larger dynamic ecosystem. Negative impacts on habitat from hydrocarbon development, coupled with other ongoing activities such as commercial, sport, and subsistence fisheries, could compromise some of these species. Several of the riverine fish species found along the proposed MGP route are sensitive – possessing a lower tolerance to withstand over harvesting and habitat degradation – and as such are more susceptible to negative effects on habitat associated with pipeline development. Riverine species are most at risk to habitat degradation since the proposed MGP route will cross numerous tributaries flowing into the Mackenzie River which are used primarily for spawning or as access to spawning

sites. Eleven species from this area are important to subsistence and sport fisheries and are considered to be vulnerable to environmental disturbance: Arctic grayling (*Thymallus arcticus*), bull trout (*Salvelinus confluentus*), Dolly Varden (*Salvelinus malma*), Arctic cisco (*Coregonus autumnalis*), least cisco (*Coregonus sardinella*), inconnu (*Stenodus leucichthys*), walleye (*Sander vitreus*), broad whitefish (*Coregonus nasus*), lake whitefish (*Coregonus clupeaformis*), round whitefish (*Prosopium cylindraceum*), and burbot (*Lota lota*) (Stein et al. 1973). Pearl dace (*Margariscus margarita*) and brook stickleback (*Culaea inconstans*) are also important components of the ecosystem as they are consumed by many of the species identified above (Stein et al. 1973).

To minimize impacts of anticipated hydrocarbon development, it is important to understand differential habitat use and distribution of fish species, and their life history types and stages. At community workshops in 2003, it was established that this information was lacking for many streams along the proposed pipeline route (Gartner Lee Ltd. 2003; Gartner Lee Ltd. 2004). The objectives of this study are to improve our understanding of biodiversity below the species level (e.g., life history types), geographic distribution, and habitat associations for different life history and life stages of each sensitive fish species. Small streams with seasonal flow will be the focus since it is not explicitly clear how these streams function to maintain fish populations and the extent of their contribution to the larger Mackenzie River system. The project will run for a minimum of two years to obtain pre-development baseline information for comparative post-development monitoring.

MATERIALS AND METHODS

STUDY AREA

The Deh Cho Region extends from the Alberta and British Columbia borders north along the Mackenzie River Valley to the Redstone River and southern portion of Great Bear Lake (Fig. 1). Fort Simpson, Fort Liard, Fort Providence, Hay River, Jean Marie River, Kakisa, Nahanni Butte, Trout Lake, West Point, and Wrigley are the communities established in this area. Within the Deh Cho Region, the Mackenzie River flows approximately 460 km north from the Great Slave Lake outflow to the Sahtu Settlement Area border. The Mackenzie River receives freshwater input from the Great Slave Lake outflow, and from tributaries ranging in size from seasonal swales to large rivers (e.g., Liard River).

The tributaries found along the east side of the Mackenzie River in the Deh Cho Region originate in the Franklin Mountains and those found on the west side originate in the Nahanni Mountains. Streams running into the Mackenzie River flow either year round or seasonally and peak discharge is just after the spring freshet. River levels and flows are lowest in the late summer/early fall and some streams run dry by mid to late summer; however, some fish species may still use these streams seasonally for spawning, rearing, and feeding. The tributaries found in this

area are high-gradient, mountain streams that run clear after the spring freshet. Stream discharge is governed primarily by snow melt and precipitation during the open water season but in many streams groundwater also influences flows during the year. Most of the smaller tributaries freeze completely to the bottom during winter; however, large tributaries with sufficient depth, flow, or discharging groundwater do not. Larger rivers (i.e., 20 to 30 m wide) such as the Liard and Ochre rivers carry a relatively high sediment load after the spring freshet and for much of the open water season. Turbidity levels in these rivers are influenced by precipitation in the mountains during the open water season. Groundwater is found in some streams across the region and provides summer and winter refuges for fish.

BIOLOGICAL DATA COLLECTION

Field work was conducted from July 18 to July 22, 2006. Streams were selected based on knowledge gaps identified by DFO as well as the request by local communities to gain a better understanding of the fish species using streams along the proposed MGP corridor. Site selection was also driven by our understanding of the distribution of sensitive species in the area. Surveys were conducted at three different streams in the Deh Cho Region (Fig. 1). Fish were captured using a backpack electro-fisher (Smith-Root Type VII POW). Streams were stratified into lower, middle, and upper sections and stations ranging in length from 120 m to 320 m were fished in these sections. Co-ordinates were taken at the central point of each station (North American Datum 1983, Canada) that was fished with a Garmin (GPSMAP 60C) hand-held global positioning system (GPS). In some situations streams were only sampled in one or two sections due to logistical constraints.

To minimize research impacts on populations, a combination of live- and dead-sampling was conducted.

LIVE SAMPLING

All fish captured were identified to species where possible. A total count of individuals and the range (i.e., minimum and maximum) of fork lengths (FL) were taken for smaller forage fish (e.g., cyprinids), which were not considered sensitive species but were abundant in the catch. Fish were placed in a holding bag which was anchored in slow moving water providing a well-oxygenated recovery environment before and after field processing. Biological data, which included fork length (nearest mm), weight (nearest g), sex, and maturity (Table 1; McGowan 1992) were documented for all sensitive species where possible. Life history type and life stages were assigned based on external characteristics, such as size, color, and presence of unique marks (e.g., parr marks). Fish with fork lengths > 200 mm were fitted with a uniquely numbered T-bar tag inserted at the base of the dorsal fin between the posterior basal pterygiophores. A portion of the adipose fin was removed from all tagged fish, as well as a random sub-sample of smaller fish from various locations, for genetic analysis and as a secondary marking method.

Once biological data were recorded, fish were released at the same location where they were originally captured.

DEAD SAMPLING

A limited number of fish were sacrificed for confirmation of species' identity and to acquire additional biological information. Fish were placed in 10% buffered formalin for 1-2 weeks, soaked twice in freshwater for 24 hours, and then transferred into 70% ethanol. Preserved fish were shipped to DFO (Winnipeg, MB) for subsequent analysis. All fish were identified to species (McPhail and Lindsey 1970; Scott and Crossman 1973) and fork lengths (nearest mm) and weight (nearest 0.1 g) were recorded. Additionally sex, maturity, and gonad weight (nearest 0.1 g) were documented where possible for all Arctic grayling, burbot, and round whitefish collected. Sexual maturity was determined by internal examination of gonads and each fish was assigned a maturity code (Table 1; McGowan 1992). The liver from each burbot was photographed, and weighed. Stomachs and livers were also preserved in 70% ethanol for subsequent analysis.

Fish ages were determined using the whole (Secor et al. 1992), sectioned (Secor et al. 1992), or break-and-burn (Chilton and Beamish 1982) otolith methods.

HABITAT DATA COLLECTION

Habitat information was collected from selected streams to describe the type of habitat available for fish and determine how sensitive species use this habitat. Habitat use was quantified at the macrohabitat and microhabitat level for each stream. Macrohabitat represents general physical features (e.g., depth, velocity, substrate, wetted width) of a stream. Microhabitat represents the physical features of the stream at specific positions where fish are captured within the stream (Goetz 1997).

MACROHABITAT DATA COLLECTION

Macrohabitat was measured along transects in randomly selected reaches (stations) of each stream. One station was randomly selected from the lower, middle, and upper sections of each stream. Stations ranged in length from 160 m to 360 m. The stations selected in each section were 40 mean stream widths (MSW) in length and 13–20 transects were sampled within each station. The MSW was based on 5-10 preliminary measurements (nearest 0.5 m) of the wetted stream width taken at the downstream end of each station. Simonson et al. (1994) show that a minimum of 13 transects with four data points across each transect should be sampled in a station to obtain an accurate representation of the habitat present. Habitat was not measured in all three sections of some streams because of logistical constraints (e.g., no safe landing areas).

Transects were spaced two MSW apart and placed perpendicular to water flow. This systematic placement of transects ensured that a maximum of 20 transects could be sampled within a station. At four equidistant points across each transect water depth, water velocity, substrate and cover types, and water temperature were measured. Depth was measured with a meter stick (nearest 0.5 cm), and velocity was measured at 60% of the water depth using a Marsh-McBirney flow meter (accurate to 0.01 $m \cdot s^{-1}$). Dominant substrate was estimated visually in the surrounding 5 cm for each point using a modified Wentworth scale (Table 2) and cover was estimated visually according to a ranked classification scale (Table 3). Temperature was recorded at the bottom of the river bed within the substrate using a hand-held DigiSense Thermister Thermometer™ attached to a metal probe. The metal probe was armored in a steel sheath and driven as far into the river bottom as possible. Ambient river temperature was also recorded at one minute intervals halfway down the water column, while on site with Stowaway Tidbit Temperature Loggers™. The mean depth and water velocity were determined for each station, and the mode was determined for substrate and cover types.

MICROHABITAT DATA COLLECTION

Microhabitat was quantified at specific positions in the stream where Arctic grayling, whitefish, and burbot were captured. Most of the habitat use data are for Arctic grayling as this was the sensitive species encountered most often during field work. A two-person crew electrofished randomly selected stations in each stream. Each time one of these species was captured a weighted colored marker, representing either juvenile or adult fish, was placed in the habitat unit for later identification. Lengths (nearest mm) were recorded for all fish captured. All Arctic grayling greater than 300 mm were considered adults and those less than 300 mm were considered juveniles based on size-at-age data. Water depth, water velocity, dominant substrate and cover were recorded at the point where the marker was dropped as well as four points approximately 10 cm around the central point in a clockwise direction at 0°, 90°, 180°, and 270°.

RESULTS

Common and scientific names with corresponding species codes for all species captured are presented in Table 4. Table 5 shows location information, method, effort expended to capture fish, number of fish tagged and released, number of fish dead-sampled, and catch-per-unit-effort. A total of 223 fish representing eight different species were captured. Slimy sculpin was the most abundant species in this area representing 70.4 % of the total catch followed by lake chub (16.6 %), Arctic grayling (6.3 %), burbot (2.2 %), white sucker (2.2 %), and northern pike (1.3 %). Emerald shiner and round whitefish accounted for only 0.8 % of the catch. Lake chub were found in all of the streams surveyed. Table 6 summarizes biological data obtained from emerald shiner, lake chub, northern pike, slimy sculpin, and white sucker. Similar biological data are presented in Table 7 for sensitive species captured. Habitat data showed that the mean depths ranged from 7.8 cm to 46.3 cm, mean velocities ranged from 0.19 $m \cdot s^{-1}$ to 0.73 $m \cdot s^{-1}$, cobble

and pebble was the most common substrate found, and cobble and boulder was the predominant cover (Table 8). Mean temperatures were 13.3 °C for Smith Creek and 16.5 °C for White Sand Creek (Table 8).

ACKNOWLEDGEMENTS

This project was funded by Fisheries and Oceans Canada through the Mackenzie Gas Pipeline Sensitive Fish Species Program, which was supported by Indian and Northern Affairs Canada. D. Moses from the Pehdzeh Ki First Nation is thanked for his assistance in communications and coordinating personnel for this study. We thank R. Wastle for preparing and ageing fish structures, and P. Cott for logistic support. Special thanks to N. Tale, M. Somers, and S. Tan, for assistance in the field. A. Majewski and J. Johnson provided constructive comments on an earlier version of the manuscript.

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Table 1. Sexual maturity codes assigned to fish captured during the study (McGowan 1992).

Maturity State	Male – 1	Female – 2
Immature	06 – testes long and thin, tubular and scalloped shape, up to full body length, putty-like firmness	01 – ovaries granular, hard and triangular, up to full length of body cavity, membrane full, eggs distinguishable
Mature	07 – current year spawner, testes large and lobate, white to purplish in color, centres may be fluid, milt not expelled by pressure	02 – current year spawner, ovary fills body cavity, eggs near full size but not loose and not expelled by pressure
Ripe	08 – testes full size, white and lobate, milt expelled by slight pressure	03 – ovaries greatly extended and fill body cavity, eggs full size and transparent, expelled by slight pressure
Spent	09 – spawning complete, testes flaccid with some milt, blood vessels obvious, testes violet-pink in colour	04 – spawning complete, ovaries ruptured and flaccid, developing oocytes visible, some eggs retained in body cavity
Resting	10 – testes tubular, less lobate, healed from spawning, no fluid in center, usually full length of body, mottled and purplish in colour	05 – ovary 40 – 50% of body cavity volume, membrane thin and semi-transparent, healed from spawning, developing oocytes apparent with few atretic eggs, some eggs may be retained in body cavity
Unknown (virgin)	00 – cannot be sexed, gonads long or short and thin, transparent or translucent	
Unknown (non-virgin)	11 – resting fish, has spawned but gonads regenerated, or sexing not possible	

Table 2. Modified Wentworth classification of substrate types by size used for stream surveys in the Deh Cho Region (Cummins 1962).

Code	Particle size range (mm)	Substrate definition
5	> 256	Boulder
4	64 - 255	Cobble
3	16 - 63	Pebble
2	2 - 15	Gravel
1	0.06 - 1	Sand
0	< 0.059	Silt

Table 3. Cover classification defining types for stream surveys conducted in the Deh Cho Region (Sexauer and James 1997).

Code	Type or size range	Cover definition
1	aquatic vegetation	Submerged vegetation
2	riparian vegetation	Overhanging vegetation
3	water column depth	Depth
4	water turbulence	Turbulence
5	65 - 255 mm	Cobble
6	256+ mm	Boulder
7	> 30 cm diameter	Large wood
8	< 30 cm diameter	Small wood
9	stable bank, undercut	Undercut bank
10	none of the above are applicable	No cover

Table 4. Fish species captured during stream surveys in the Deh Cho Region during summer, 2006.

Common Name	Scientific Name	Species Code
Arctic grayling	*Thymallus arcticus*	ARGR
Burbot	*Lota lota*	BURB
Emerald shiner	*Notropis atherinoides*	EMSH
Lake chub	*Couesius plumbeus*	LKCH
Northern pike	*Esox lucius*	NRPK
Round whitefish	*Prosopium cylindraceum*	RNWH
Slimy sculpin	*Cottus cognatus*	SLSC
White sucker	*Catostomus commersoni*	WHSC

Table 5. Fish inventory data for all species captured during electrofishing surveys in the Deh Cho region, 2006.

Capture location	Site No.	Date M/D/Y	Effort (s)	Species	No. of fish	No. of fish released	No. of fish dead-sampled	CPUE fish/100 s
Hodgson Creek	1	07/19/06	1503	LKCH	1	1	0	0.1
63° 20.010' N, 123° 25.992' W				NRPK	1	1	0	0.1
				SLSC	5	5	0	0.3
Total					**7**	**7**	**0**	**0.5**
Tributary (1) to Hodgson Creek	2	07/19/06	850	ARGR	3	0	3	0.4
63° 20.032' N, 123° 25.966' W				LKCH	6	0	6	0.7
				SLSC	28	0	28	3.3
Total					**37**	**0**	**37**	**4.4**
Tributary (2) to Hodgson Creek	3	07/20/06	1947	BRBT	1	0	1	0.1
63° 16.296' N, 131 27.430' W				EMSH	1	0	1	0.1
				LKCH	22	0	22	1.1
				SLSC	15	13	2	0.8
Total				WHSC	1	0	1	0.1
					40	**13**	**27**	**2.1**
Smith Creek Reach 1	4	07/18/06	2098	ARGR	2	1	1	0.1
63° 10.462' N, 123° 20.296' W				BRBT	2	0	2	0.1
Smith Creek Reach 1 (Continued).				LKCH	2	0	2	0.1
				NRPK	1	1	0	0.0
				SLSC	55	54	1	2.6
				WHSC	1	1	0	0.0
Total					**63**	**57**	**6**	**3.0**

Capture location	Site No.	Date M/D/Y	Effort (s)	Species	No. of fish	No. of fish released	No. of fish dead-sampled	CPUE fish/100 s
Smith Creek Reach 1	4	07/22/06	2705	ARGR	3	1	2	0.1
63° 10.487' N, 123° 20.246' W				BRBT	2	0	2	0.1
				LKCH	3	3	0	0.1
				NRPK	1	1	0	0.0
				SLSC	22	22	0	0.8
				WHSC	1	1	0	0.0
				RNWH	1	0	1	0.0
Total					**33**	**28**	**5**	**1.2**
Smith Creek Reach 2	5	07/21/06	1058	-	0	0	0	0.0
63° 10.503' N, 123° 15.971' W								
Total					**0**	**0**	**0**	**0.0**
Smith Creek Reach 3	6	07/21/06	1681	SLSC	23	8	15	1.4
63° 10.814' N, 123° 20.114' W								
Total					**23**	**8**	**15**	**1.4**
White Sand Creek	7	07/20/06	2754	ARGR	6	1	5	0.2
63° 33.896' N, 123° 38.712' W				LKCH	3	0	3	0.1
				SLSC	9	7	2	0.3
				WHSC	2	1	1	0.1
Total					**20**	**9**	**11**	**0.7**

Table 6. Biological data for both live- and dead-sampled emerald shiner, lake chub, northern pike, slimy sculpin, and white sucker captured in streams from the Deh Cho Region during summer, 2006. DS = dead sampled, LR = live release.

Location	Site No.	Latitude (N)	Longitude (W)	Date M/D/Y	No.	Species	FL (mm)	Wt (g)	Fish Fate
Hodgson Cr.	1	63° 20.010'	123° 25.992'	07/19/06	1	LKCH	-	-	LR
63° 20.010' N, 123° 25.992' W					2	NRPK	310	-	LR
Hodgson Cr. tributary 1	2	63° 20.032'	23° 25.966'	07/19/06	3	LKCH	70	3.6	DS
63° 20.032' N, 123° 25.966' W					4	LKCH	57	1.2	DS
					5	LKCH	52	1.7	DS
					6	LKCH	59	1.9	DS
					7	LKCH	53	1.8	DS
					8	LKCH	50	1.4	DS
					9	SLSC	93	7.3	DS
					10	SLSC	82	4.3	DS
					11	SLSC	83	5.4	DS
					12	SLSC	39	0.3	DS
					13	SLSC	45	0.8	DS
					14	SLSC	37	0.5	DS
					15	SLSC	41	0.6	DS
					16	SLSC	42	0.6	DS
					17	SLSC	47	0.9	DS
					18	SLSC	45	0.8	DS
					19	SLSC	41	0.5	DS
					20	SLSC	51	1.2	DS
					21	SLSC	42	0.6	DS
					22	SLSC	41	0.5	DS
					23	SLSC	35	0.1	DS
					24	SLSC	87	6.6	DS
					25	SLSC	45	0.8	DS

Location	Site No.	Latitude (N)	Longitude (W)	Date M/D/Y	No.	Species	FL (mm)	Wt (g)	Fish Fate
Hodgson Cr. tributary 1 (Continued).					26	SLSC	45	1.0	DS
					27	SLSC	44	0.8	DS
					28	SLSC	45	1.0	DS
					29	SLSC	53	1.7	DS
					30	SLSC	41	0.7	DS
					31	SLSC	41	0.7	DS
					32	SLSC	45	1.0	DS
					33	SLSC	40	0.6	DS
					34	SLSC	41	0.7	DS
					35	SLSC	46	1.0	DS
					36	SLSC	37	0.5	DS
Hodgson Cr. tributary 2 63° 16.296' N, 131 27.430' W	3	63° 16.296'	131 27.430'	07/20/06	37	EMSH	46	0.9	DS
					38	LKCH	53	1.8	DS
					39	LKCH	49	1.4	DS
					40	LKCH	59	2.5	DS
					41	LKCH	66	3.4	DS
					42	LKCH	84	7.8	DS
					43	LKCH	71	4.2	DS
					44	LKCH	58	2.3	DS
					45	LKCH	57	2.3	DS
					46	LKCH	57	2.4	DS
					47	LKCH	50	1.7	DS
					48	LKCH	56	2.1	DS
					49	LKCH	52	1.3	DS
					50	LKCH	54	1.8	DS
					51	LKCH	64	3.3	DS
					52	LKCH	55	1.9	DS
					53	LKCH	54	1.8	DS
					54	LKCH	54	2.2	DS

Location	Site No.	Latitude (N)	Longitude (W)	Date M/D/Y	No.	Species	FL (mm)	Wt (g)	Fish Fate
Hodgson Cr. tributary 2 (Continued).					55	LKCH	55	1.9	DS
					56	LKCH	52	1.6	DS
					57	LKCH	63	3.0	DS
					58	LKCH	57	2.3	DS
					59	LKCH	55	1.9	DS
					60	SLSC	79	-	LR
					61	SLSC	39	0.7	DS
					62	SLSC	52	-	LR
					63	SLSC	40	-	LR
					64	SLSC	60	-	LR
					65	SLSC	46	1.1	DS
					66	WHSC	115	12.4	DS
White Sand Cr. 63° 33.896' N, 123° 38.712' W	7	63° 33.896'	123° 38.712'	07/20/06	67	LKCH	65	2.4	DS
					68	LKCH	74	3.9	DS
					69	LKCH	95	6.3	DS
					70	SLSC	50	-	LR
					71	SLSC	38	0.1	DS
					72	SLSC	42	0.2	DS
					73	WHSC	75	4.3	DS
					74	WHSC	85	-	LR
Smith Cr. Reach 3 63° 10.814' N, 123° 20.114' W	6	63° 10.814'	123° 20.114'	07/21/06	75	SLSC	75	4.6	DS
					76	SLSC	45	0.9	DS
					77	SLSC	44	0.9	DS
					78	SLSC	50	1.5	DS
					79	SLSC	47	1.2	DS
					80	SLSC	40	0.7	DS
					81	SLSC	46	1.0	DS

Location	Site No.	Latitude (N)	Longitude (W)	Date M/D/Y	No.	Species	FL (mm)	Wt (g)	Fish Fate
Smith Cr. Reach 3					82	SLSC	51	1.6	DS
(Continued).					83	SLSC	48	1.3	DS
					84	SLSC	33	0.4	DS
					85	SLSC	49	1.2	DS
					86	SLSC	41	0.8	DS
					87	SLSC	43	0.9	DS
					88	SLSC	39	0.7	DS
					89	SLSC	37	0.6	DS
					90	SLSC	88	-	LR
					91	SLSC	90	-	LR
					92	SLSC	60	-	LR
					93	SLSC	52	-	LR
					94	SLSC	71	-	LR
					95	SLSC	63	-	LR
					96	SLSC	73	-	LR
					97	SLSC	39	-	LR
Smith Cr. Reach 1	4	63° 10.487'	123° 20.246'	07/22/06	98	LKCH	71	4.6	DS
63° 10.487' N, 123° 20.246' W					99	LKCH	54	2.0	DS
					100	NRPK	108	-	LR
					101	SLSC	40	0.4	DS
					102	WHSC	64	-	LR
					103	LKCH	72	3.7	DS
					104	LKCH	69	3.9	DS
					105	LKCH	54	1.5	DS
					106	NRPK	449	-	LR
					107	WHSC	110	-	LR

Table 7. Biological data collected for both live - and dead-sampled Arctic grayling, burbot, and round whitefish captured in streams from the Deh Cho region during summer, 2006. 1. Five digit codes (e.g., 47257) are DFO (Winnipeg) archival numbers; 2. see Table 1 for sex and maturity codes, 3. A = adult, J = Juvenile, YOY = young-of-the-year; 4. DS = dead-sampled, LR = live release.

Location	Site No.	Date M/D/Y	No.	Fish ID[1]	Species	FL (mm)	Wt (g)	Sex	Mat.[2]	Age (yr +)	Life Stage[3]	Fish Fate[4]
Hodgson Cr. tributary 1	2	07/19/06	1	51006	ARGR	82	6.4	-	00	1	J	DS
63° 20.032' N, 123° 25.966' W			2	51007	ARGR	93	9.5	-	00	1	J	DS
			3	51008	ARGR	85	5.6	-	00	1	J	DS
Hodgson Cr. tributary 2	3	07/20/06	4	51009	BRBT	291	116.1	1	07	5	A	DS
63° 16.296' N, 131 27.430' W												
Smith Cr. Reach 1	4	07/18/06	5	51001	ARGR	126	17.7	1	06	-	J	DS
63° 10.462' N, 123° 20.296' W			6	51002	ARGR	101	9.6	-	00	1	J	DS
			7	-	ARGR	135	-	-	00	-	J	LR
Smith Cr. Reach 1	4	07/22/06	8	51015	ARGR	50	1.1	-	00	0	YOY	DS
63° 10.487' N, 123° 20.246' W			9	-	ARGR	52	-	-	-	-	YOY	LR
			10	51004	BRBT	190	32.5	-	11	4	-	DS
			11	51005	BRBT	79	3.0	-	00	2	J	DS
			12	51016	BRBT	125	12.5	-	-	3	-	DS
			13	51017	BRBT	216	61.0	-	11	4	-	DS
			14	51003	RNWH	90	7.4	-	00	2	J	DS
White Sand Cr.	7	07/20/06	15	51010	ARGR	41	0.4	-	00	-	YOY	DS
63° 33.896' N, 123° 38.712' W			16	51011	ARGR	39	0.1	-	00	-	YOY	DS
			17	51012	ARGR	39	0.4	-	00	-	YOY	DS
			18	51013	ARGR	40	0.5	-	00	0	YOY	DS
			19	51014	ARGR	41	0.6	-	00	0	YOY	DS
			20	-	ARGR	127	-	-	00	-	J	LR

Table 8. Summary of macrohabitat data collected from streams in the Deh Cho Region during the summer, 2006. Stream order is based on the Strahler system (Gallagher 1999).

Location	Site	Latitude (N)	Longitude (W)	Stream order	Avg. wetted width (m)	Avg. temp (°C)	Month	Elevation (m) (map scale 1:50 000)	Depth (range) cm	Velocity (range) $m \cdot s^{-1}$	Dominant substrate	Dominant cover
Smith Creek	4	63° 10.462'	123° 20.296'	4	6	13.3	July	343	26.4(8-68)	0.73(0.01-3.57)	4	5
	5	63° 10.503'	123° 15.971'	4	4	-	July	700	46.3(5-116)	0.32(0.01-1.07)	3	10
	6	63° 10.814'	123° 20.114'	4	9	-	July	500	29.4(10-68)	0.36(0.01-0.85)	4	6
Hodgson Cr. - Tributary 1	2	63° 20.032'	123° 25.966'	2	3	-	July	1000	7.8(3-18)	0.34(0.01-0.92)	3	5
Hodgson Creek	1	63° 20.010'	123° 38.712'	3	8	-	July	900	27.5(10-68)	0.67(0.05-2.17)	4	6
White Sand Creek	7	63° 33.896'	123° 38.712'	4	6	16.5	July	550	25.9(6-12)	0.19(0.01-0.75)	3	5
Hodgson Cr. - Tributary 2	3	63° 16.296'	123° 27.430'	3	5	-	July	450	13.5(2-41)	0.25(0.01-0.95)	4	6

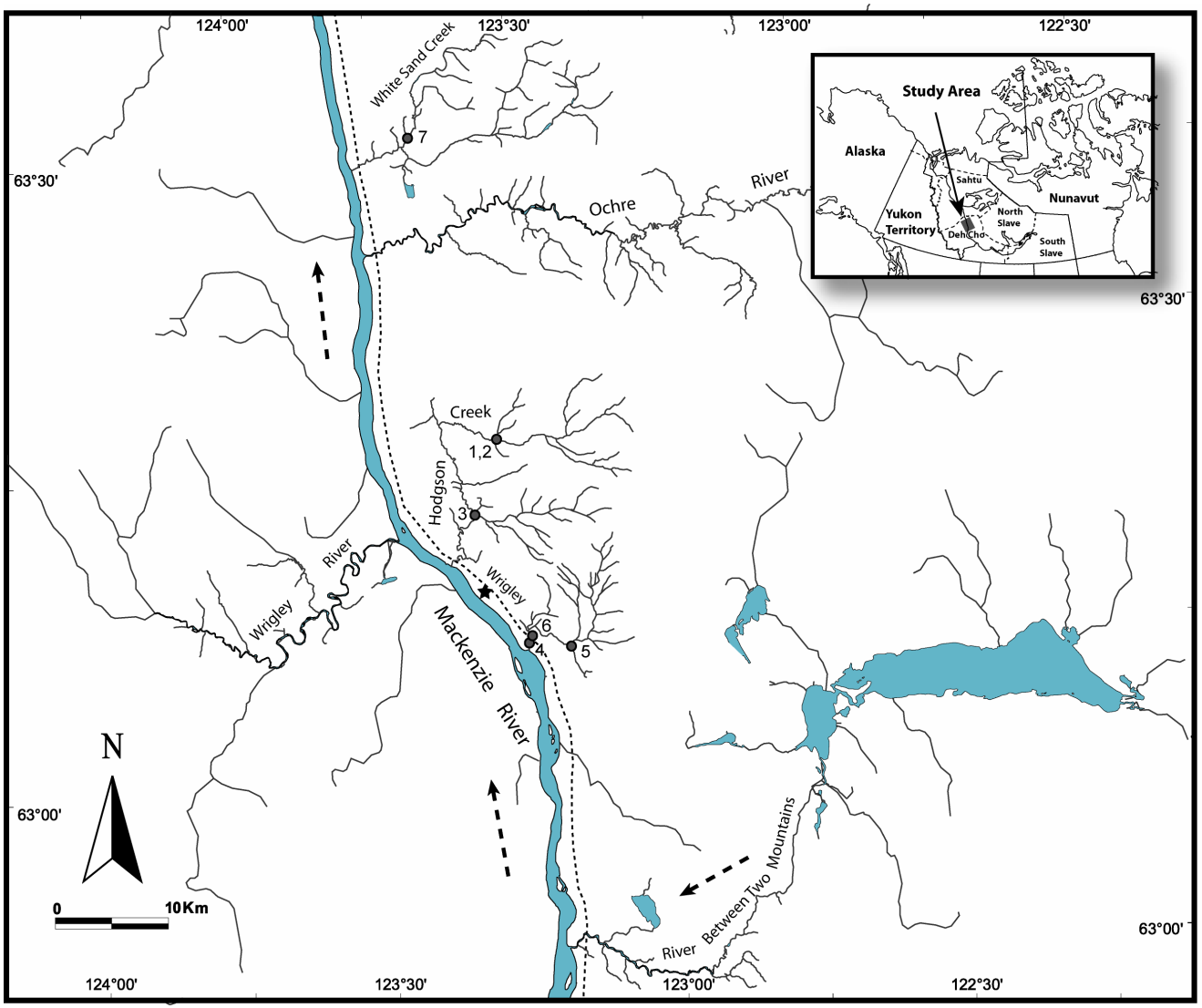

Figure 1. Sampling locations (dots) where stream surveys were conducted in the northern Deh Cho Region during summer, 2006. The dotted line shows the proposed Mackenzie Gas Pipeline route, dashed arrows indicate flow direction, and only partial drainages are shown.